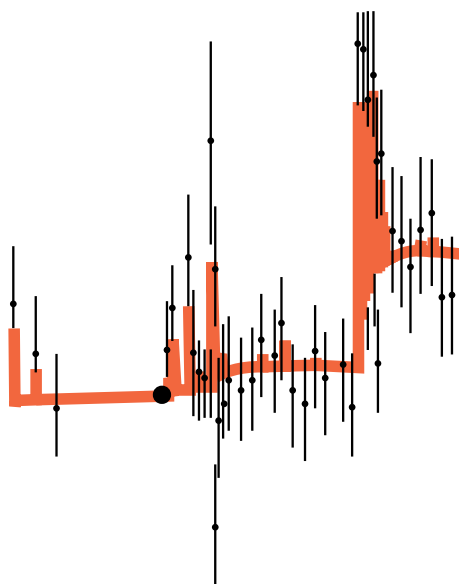
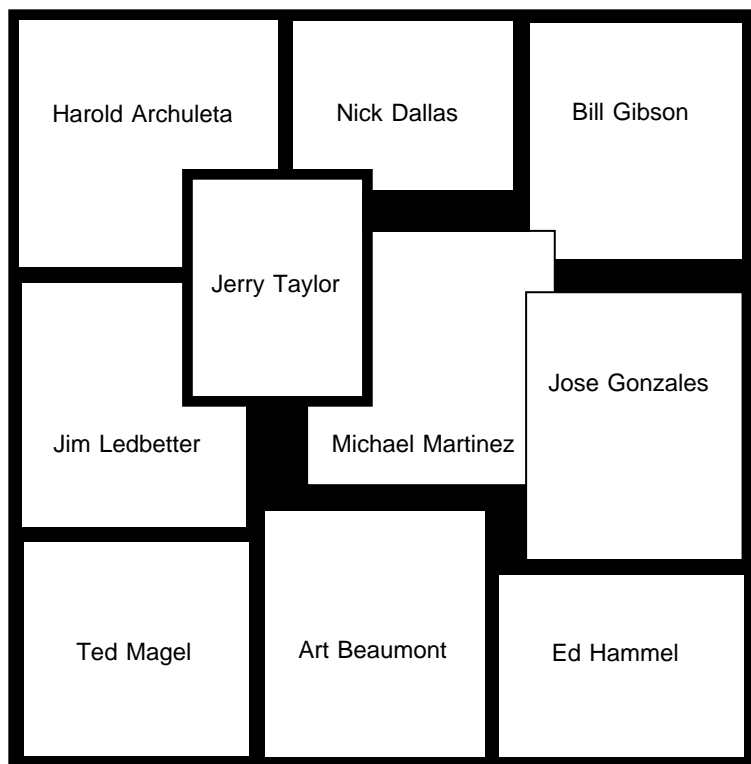


# Los Alamos Science

LOS ALAMOS NATIONAL LABORATORY





On the cover are the images of ten men who have worked with plutonium and now carry measurable body burdens of this radioactive element. Some of those individuals were at Los Alamos during the days of the Manhattan Project, and some of them are here today. In this volume on radiation protection and the human radiation experiments, these men share their experiences with plutonium, the stories of their accidents, and their perspectives on the human plutonium injection experiments. We thank them for their generosity. No doubt their stories will help others who come into similar circumstances.

As much as the plutonium injection experiments were flawed from an ethical standpoint, they did provide the bulk of the data that are now used to estimate the seriousness of an accidental intake of plutonium. Those data relate the amount of plutonium excreted in the urine to the amount retained in the body. The graph (above right) shows data points for the amount of plutonium in the urine versus time for one individual. The fit to that data made using the maximum-entropy method is shown in red. Fifty-year committed doses in rem are calculated from the urine results using biokinetic models of the time-dependent distribution of plutonium in the body. Those models are based on data gathered from the plutonium injectees as well as from the tissues of deceased plutonium workers.

Because plutonium is an ongoing responsibility of this Laboratory, the protection of those who handle that dangerous material is also our ongoing responsibility. This volume is dedicated to openness and to the proper handling of our role in plutonium work.

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# Radiation Protection and the Human Radiation Experiments

**Los Alamos**  
NATIONAL LABORATORY

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*Siegfried S. Hecker*

## I. Radiation, Cancer, and Risk—Three Primers

**Ionizing Radiation—It's Everywhere! 1** *There are a variety of myths and misconceptions about the ionizing radiation that surrounds and penetrates us all. Dispel a few of these by taking a leisurely tour of radiation and its properties, of the natural and man-made sources of ionizing radiation, and of the way doses are calculated. End your tour by estimating your own annual dose.*  
*Roger Eckhardt*

**Radiation, Cell Cycle, and Cancer 50** *By damaging DNA and inducing genetic mutations, ionizing radiation can potentially initiate a cell on the road to cancer. We review what is currently known about regulation of cellular reproduction, DNA damage and repair, cellular defense mechanisms, and the specific "cancer-causing" genes that are susceptible to ionizing radiation.*  
*Richard J. Reynolds and Jay A. Schecker*

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and Charles B. Meinhold*

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*Accidents with Plutonium*  
*Follow-up Studies, Expert Opinions, and Future Prospects*  
*Opinions about the Plutonium Injection Experiments*

*As part of the openness initiative, ten individuals who have worked with plutonium during various periods in the Laboratory's history were asked to share their experiences including their accidental intakes. Their frankness, their courage, and their pride in their accomplishments are an example for all of us. The history and prognosis of people who have had plutonium exposures is discussed by the Laboratory's leading epidemiologist.*

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*Dana Christensen*

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## RADIATION PROTECTION AND THE HUMAN RADIATION EXPERIMENTS

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*During World War II and into 1947, scientists working in the Manhattan Project had 18 people injected with plutonium. Why were these experiments performed? How dangerous were they to the people who were injected with plutonium? Was consent obtained? How was the information used? How is it being used today?*

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*The Final Report of President Clinton’s Advisory Committee on Human Radiation Experiments is reviewed herein with an emphasis on ethics and informed consent.*

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